Preliminary Assessment of the Availability of US Natural Gas Resources to Meet Transportation Energy Demand

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Topics Covered

- Background
- Recent Assessments of US Resources
- World Resources
- Non-transportation Natural Gas (NG) Demand
- Impact of Transportation Demand
- One View of Future NG Production
- Observations

Background

- This work was sponsored by US DOE, Office of Transportation Technologies
- Conducted under the Direction of Phil Patterson as part of broadly based effort to assess transportation-energy futures to 2050
- Current work being conducted in cooperation with Natural Resources Canada

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- Prior analysis indicated that natural gas is a potentially significant alternate energy source for transportation

Natural Gas and Oil Resource Summary

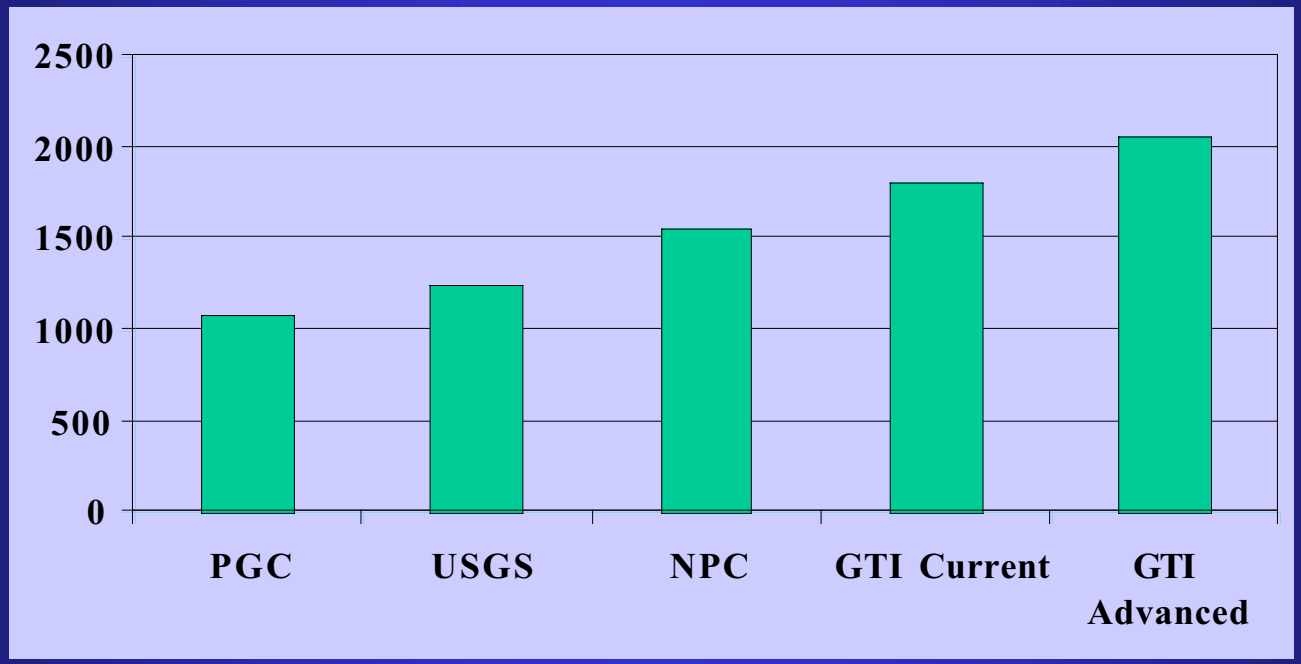
(Billion Barrels of Oil Equivalent)

Fossil Resource	Reserves	Resources	Additional Occurrences	Total
Oil				
Conventional	1,100	1,063		2,163
Unconventional	1,340	2,460	13,370	17,170
Natural Gas				
Conventional	1,030	2,050		3,080
Unconventional	1,410	1,890	2,840	6,140
Hydrates			137,500	137,500
Coal	7,350	17,570	20,860	45,780
Totals	12,230	25,033	174,570	211,833

Source: H.H. Rogner, “An Assessment of World Hydrocarbon Resources,” 1997.

Recent Assessments of US Natural Gas Resources

Trillion Cubic Feet

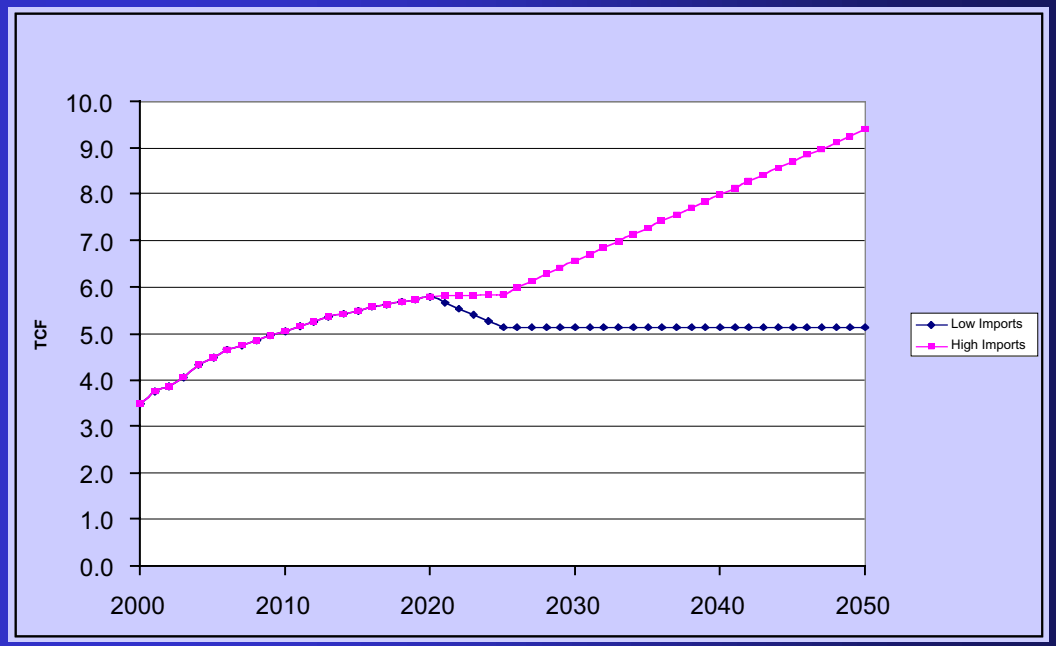


Proved Reserves Excluded, Adjusted to December 2000.

Source: Curtis, J.B.; "Comparison of Estimates of Recoverable Natural Gas Resources in the US," Col. School of Mines, Gas Resource Studies, No. 8, April 2001

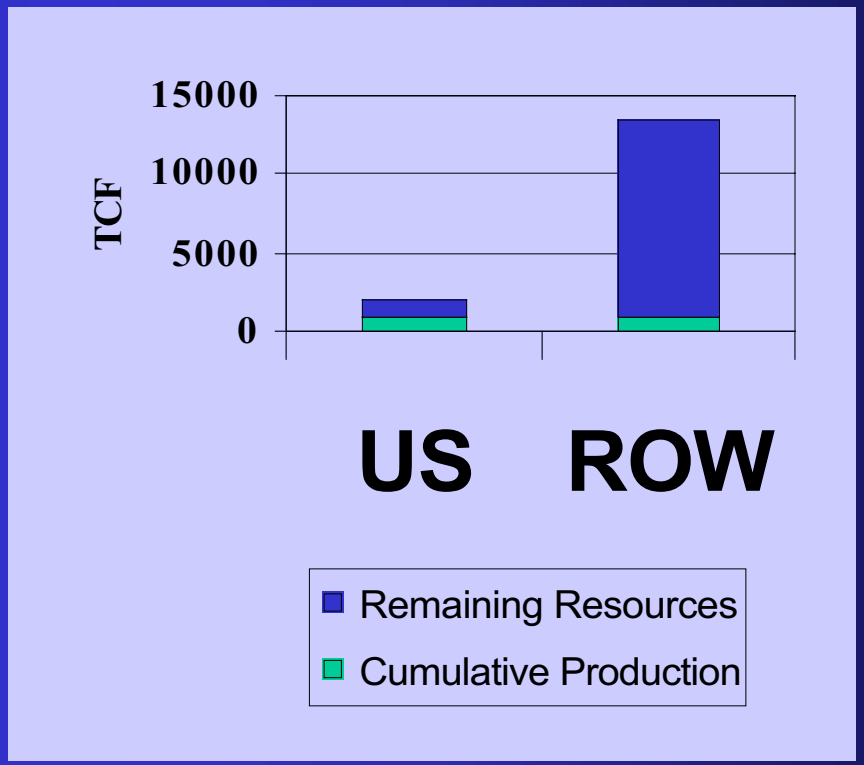
Potential for US Imports

- U.S. imports now: 3+ TCF from Canada; 0.1 TCF LNG
- Imports from Canada will grow to 2020 (5+TCF per EIA), but Canadians project decline post-2020
- Imports from Mexico not expected
  - Both EIA and PGC project continued US exports to Mexico
- ROW: Large resources, but growing demand; potential uncertain

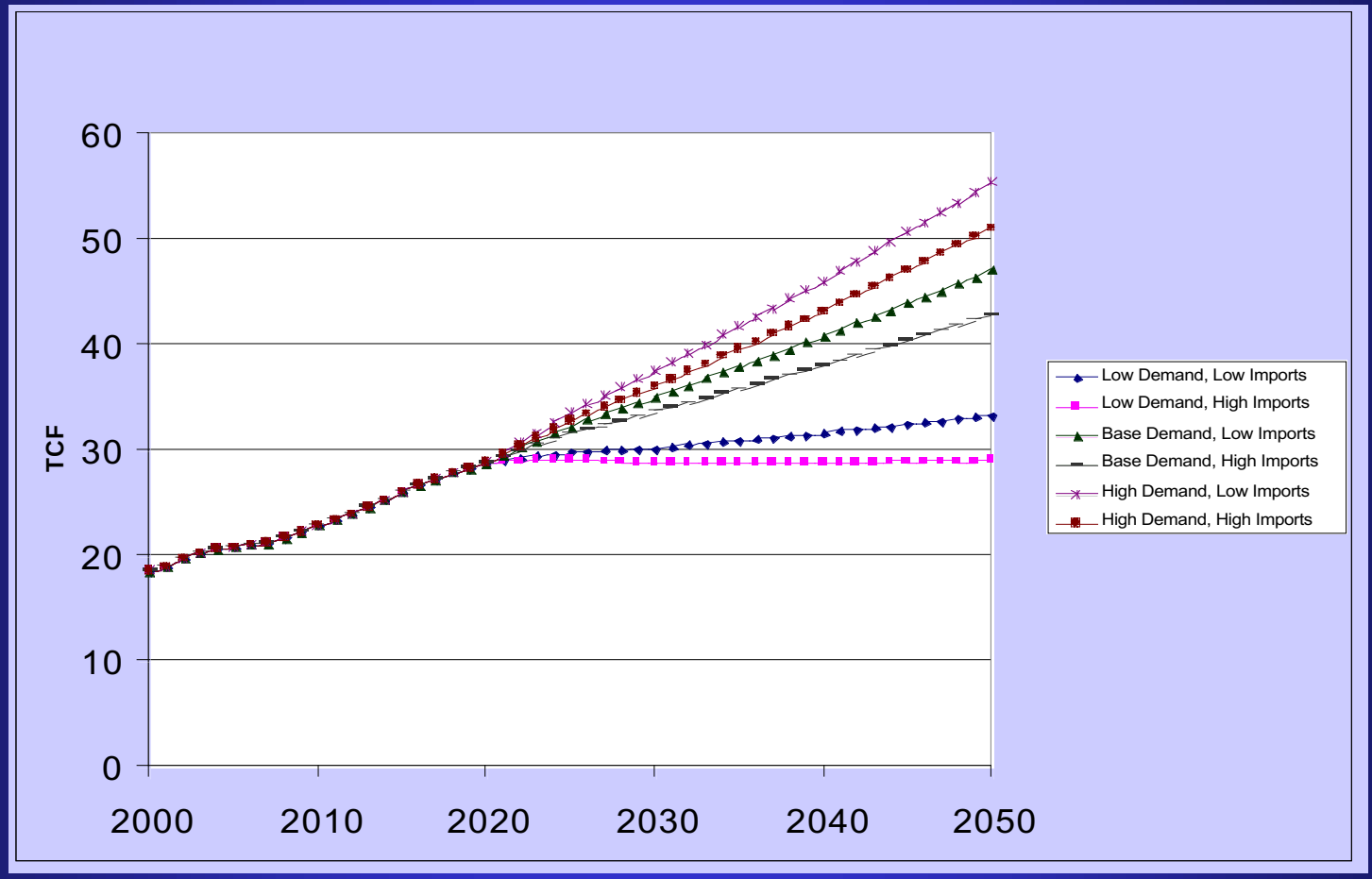


USGS Estimate of World Natural Gas Resources

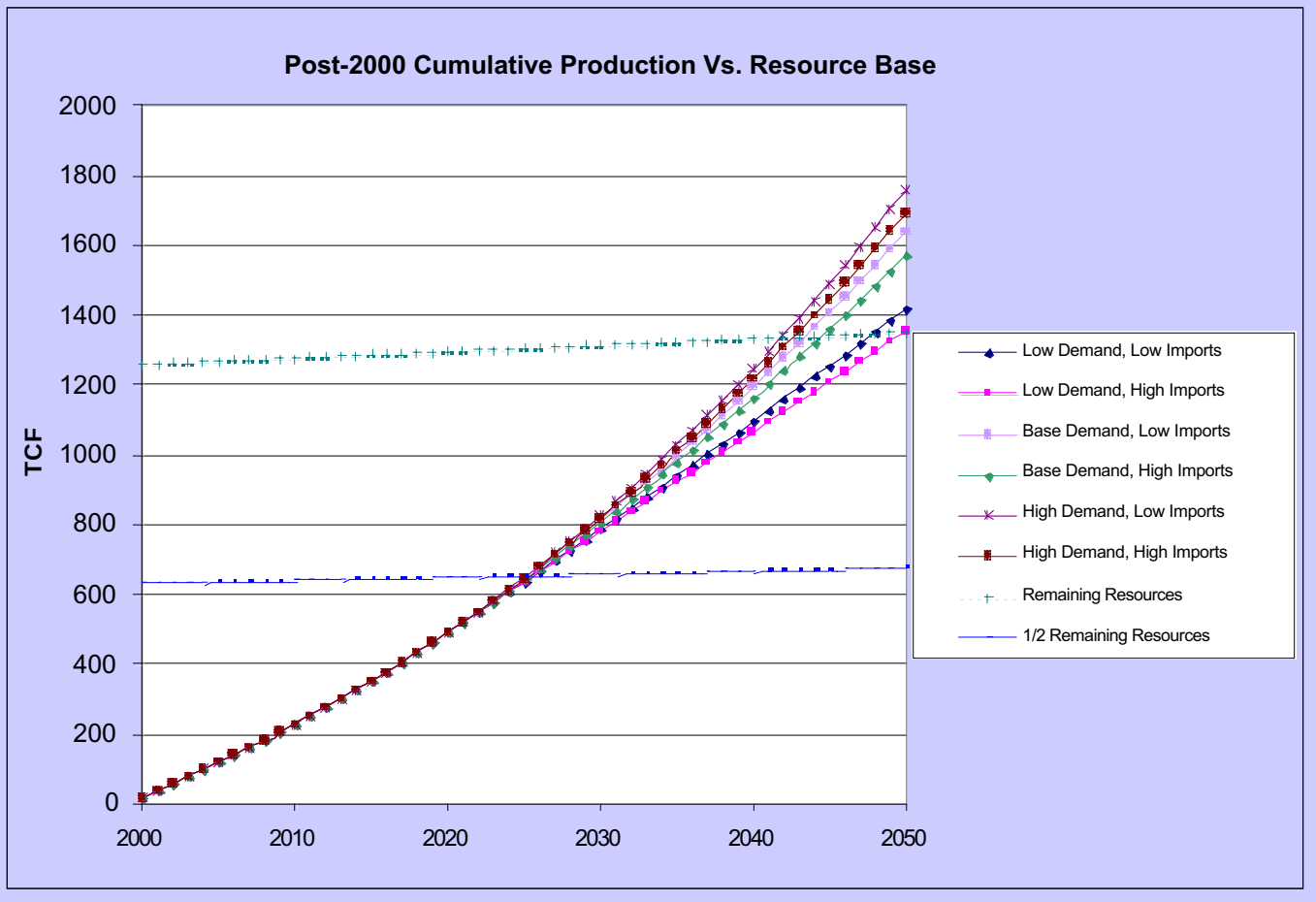
World's cumulative production similar to US, but remaining resources are much larger



Annual US Production to Meet Non-Transportation Demand



Non-transportation Natural Gas Production Alternatives

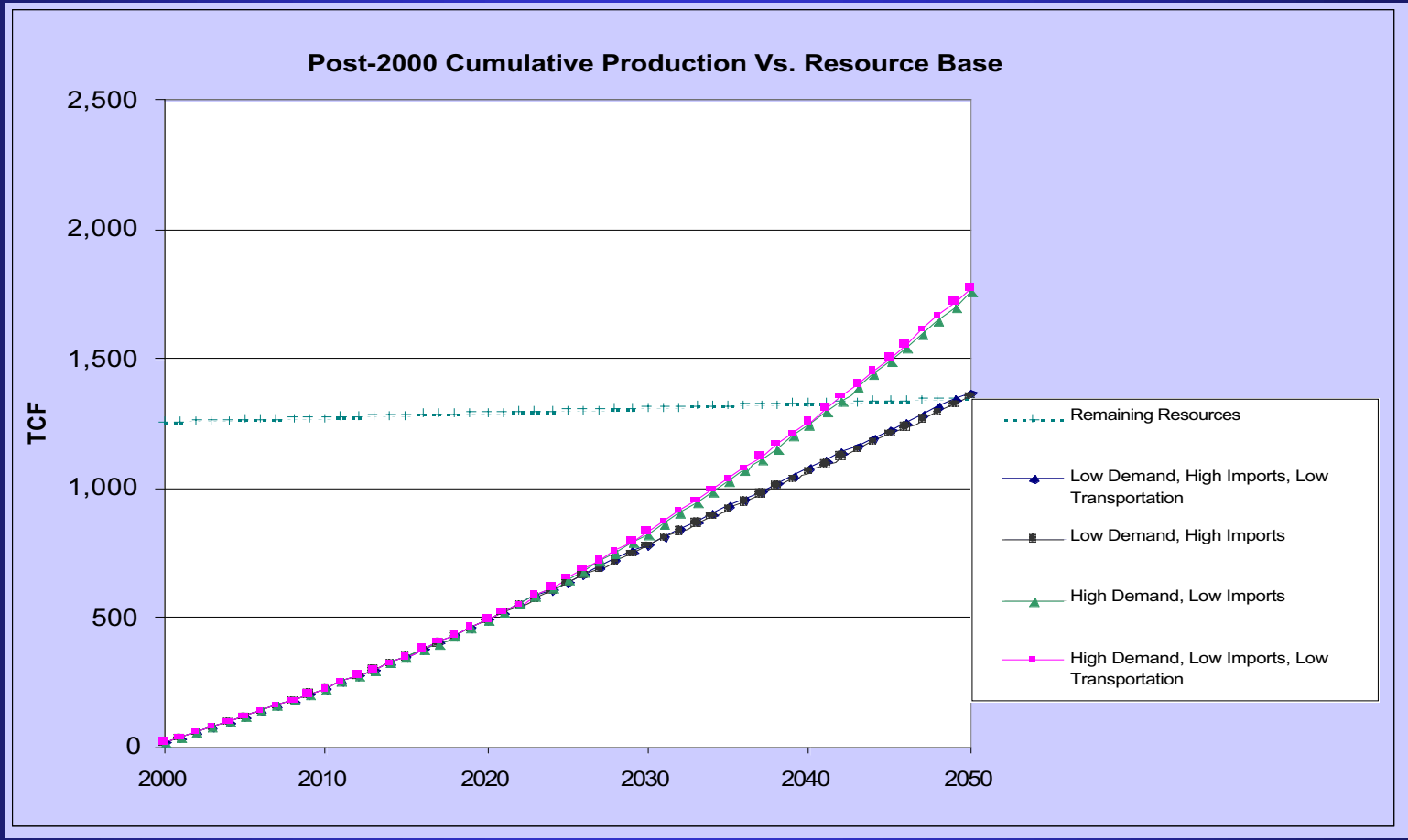


- Production paths as resource depletion approaches are unrealistic.
- Graph illustrates supply constraints.

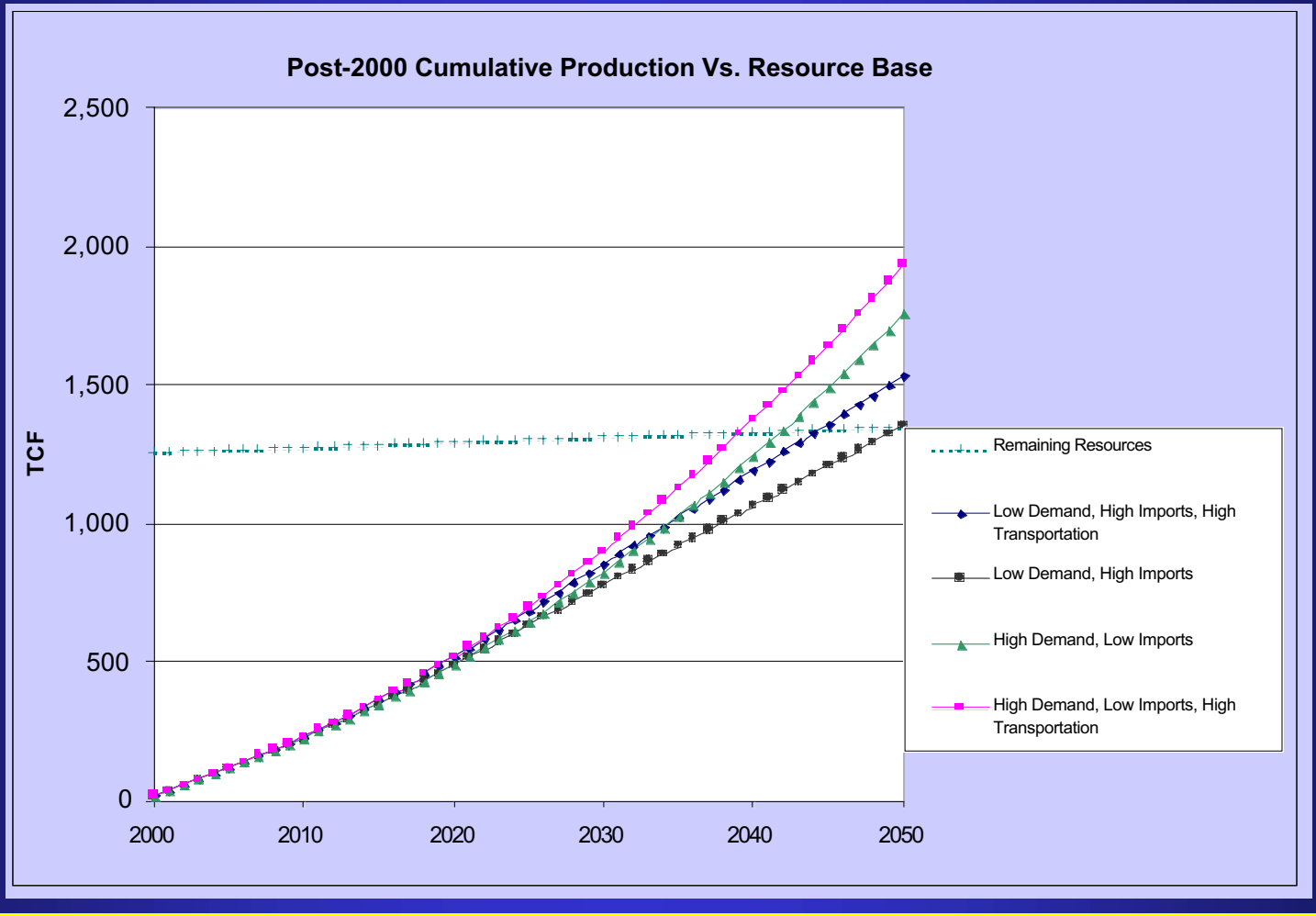
Options for Using Natural Gas In Highway Vehicles

- As an alternative fuel for spark-ignition engines
- As an alternative fuel for compression ignition engines
- As a fuel for a new power sources; e.g. fuel cells
- As a feedstock for producing another fuel:
  - Hydrogen
  - A petroleum-like product (Gas to Liquids conversion process)

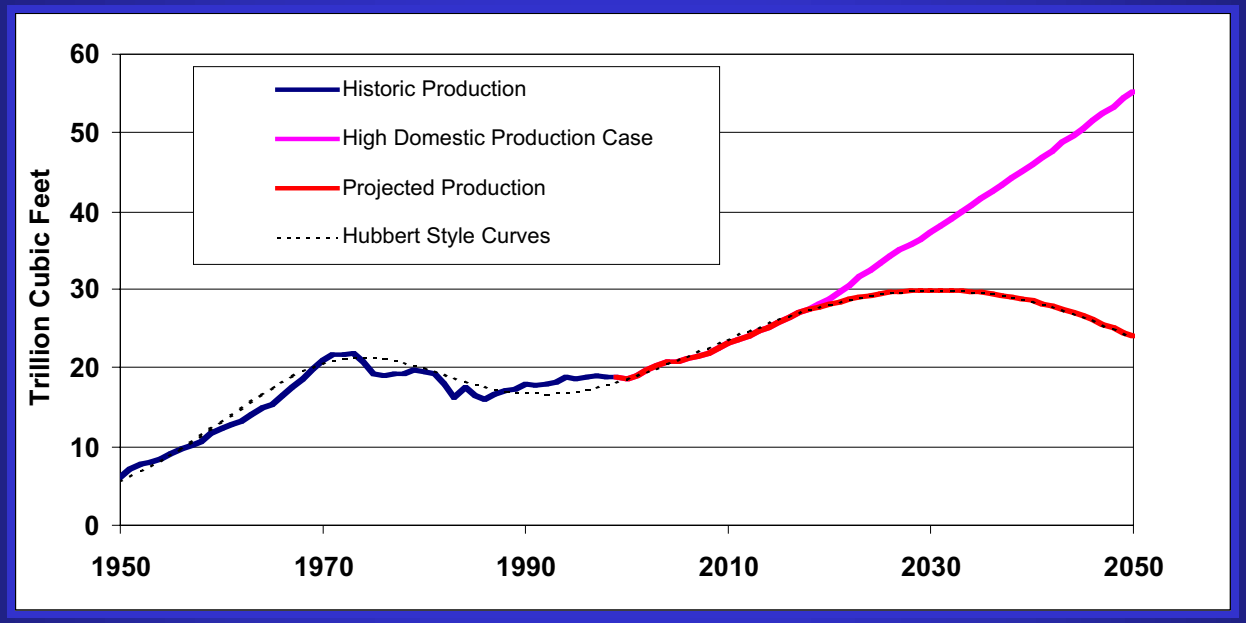
Selected Production Pathways Including Low Transportation Demand



Selected Production Pathways Including High Transportation Demand



One View of Future US Production--Linked to Resources



- The graph is based on Hubbert theory in which production declines as resources deplete below 50%
- Illustrates divergence of supply and demand post 2020

Observations

- Historically, natural gas use in light vehicles has reflected ‘fits and starts’ of interest by the gas industry
  - Driven by interest in finding new markets for gas sales
  - Affected by cost differentials between natural gas and gasoline
  - Influenced by the industry’s commitment to this market
- Transportation is the only major sector of the economy in which natural gas is not an important energy source

Observations

Based on probable resource levels, is natural gas an option as a future transportation fuel?

- Several end-use options are technically viable
- Current markets may place pressure on resource availability and fuel cost
- Viable import options appear limited

- Natural gas appears to be best suited to a transition or niche market role
  - e.g. fuel cell vehicles using H_2 from other sources
  - Or, Imports

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Transportation Analysis Web Site: www.ott.doe.gov/facts.html

Future U.S. Highway Energy Use: A Fifty Year Perspective:
www.ott.doe.gov/future_highway.shtml